Whether can the decision of the orthopositronium problem to stimulate studying the problem of a dark matter in the Universe?

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Abstract

The success of phenomenological model of the lifetime anomalies of the orthopositronium, formed in substance by β^+-decay positrons (^{22}Na, ^{68}Ga, etc.), allows to assume, that the dark matter in the Universe can be caused by realization in the β^+-decay final state and in a gravitational field of sufficient force two-digit (plus/minus) Planck mass: vacuumlike state of matter of positive mass (on Gliner, 1965) in limited macroscopic "volume" of space-time ("atom", "microstructure" of vacuum: ~ 1 km^3 during $\sim 2 \cdot 10^{-6}$s) and a compensating C-field of negative mass (on Hoyle & Narlikar, 1964). For verification this hypothesis it is necessary: for the orthopositronium problem – to realize suggested earlier (2005) concept of the experimentum crucis; in cosmology – to estimate prevalence in the Universe – on time and place – the β^+-decay transitions of the same type.

In this article the question on possible connection of the nature and "microstructure" of a dark matter in the Universe [1] with the fundamental orthopositronium (*o-Ps*, $^{\mathrm{T}}$Ps) problem [2-4] is considered.

Last work of the Michigan University group (R.S.Vallery, P.W.Zitzewitz, and D.W.Gidley, 2003 [4]), in opinion of authors, has resolved the *o-Ps* problem. Nevertheless such decision cannot be recognized unequivocal, because does not take into account "isotopic anomaly" of the *o-Ps* in gaseous neon [3,5]. All experimental works [4] have brought in the contribution to the formulation of the alternative considered by us. But last result of the Michigan group is received in qualitatively other experiment and the new experimental technique with introduction in a measuring cell of an electric field up to $4 \cdot 10^3$V/cm has allowed to finish phenomenological model of the *o-Ps* anomalies [5]. With the purpose to expand interest to the *o-Ps* problem and to execute the program of decisive experiments additional to the works [2,3,5] we consider here possibility of its cosmological aspect.

As we shall see, the key task *a priori* is an estimation of prevalence in Universe – in a place and time – the β^+-decay transitions of the certain type.

What became a basis of the assumption of the nature of a dark matter as "microstructures" of vacuum, and what its connection with the *o-Ps* problem?

Cosmic energy is entering into four basic components of space environment [1]:

• *vacuum,* with relative density

$$\Omega_{\mathrm{V}} = \frac{\rho_{\mathrm{V}}}{\rho_{\mathrm{c}}} = 0.7 \pm 0.1; \qquad (1)$$

- *dark substance*

$$\Omega_{\rm D} = \frac{\rho_{\rm D}}{\rho_{\rm c}} = 0.3 \pm 0.1; \tag{2}$$

- *shining substance of stars and galaxies* (a baryon component)

$$\Omega_{\rm B} = \frac{\rho_{\rm B}}{\rho_{\rm c}} = 0.02 \pm 0.01; \tag{3}$$

- *ultrarelativistic environment* (radiations: photons, neutrino)

$$\Omega_{\rm R} = \frac{\rho_{\rm R}}{\rho_{\rm c}} = 0.8 \cdot 10^{-5}\alpha \ (1 < \alpha < 10 \div 30), \tag{4}$$

where $\rho_{\rm c}$– *critical density*

$$\rho_{\rm c} = 3H^2/8\pi G = \ (0.6 \pm 0,1) \cdot 10^{-29}{\rm g} \cdot {\rm cm}^{-3} \tag{5}$$

and $H = 65 \pm 15\,{\rm km}{\cdot}{\rm s}^{\text{-}1}{\rm Mpk}^{-1}$– the Hubble′s constant, G – gravitational constant.

The consideration of the dark matter nature suggested below is completely coordinated with understanding, that the dark matter is traced by baryon matter.

The successful phenomenology produced for a quantitative explanation of the *o-Ps* anomalies [2-5], proves participation in its annihilation in the final state of the β^+-decay – if the β^+-decay occurs in a gravitational field of sufficient force – the *spacelike structures* occupying limited macroscopic "volume" of space-time (~ 1 km^3 during $\sim 10^{-6}$ s), in which it is uniformity distributed two-digit (and double!) Planck mass – positive ("*microstructure*" of *vacuumlike state of matter* / VSM [6]) – and compensating it the negative one (the *C*-field [7]). In other words, with each act of the β^+-decay of the certain type nucleus in the Universe it is associated huge mass (on the scale atomic/nuclear processes). In it will consist the basic idea of possible participation the β^+-decay nucleus of the certain type, which involvement into formation of the dark matter of the Universe should be estimated.

But before, we shall briefly state formulation of the question, which is directed on performance of a pilot project on the problem *o-Ps*.

Phenomenological model of the *o-Ps* anomalies [2,3,4], based on experiments, and formulation of a question on additional measurements [5] has interdisciplinary physical meaning, because frameworks of consideration of the *o-Ps* anomalies moves apart: instead of QED to supersymmetric QED (SQED). This phenomenology determines the conditions of the coexistence of a *close-action* (the Standard Model/SM, the "*cGħ*-theory" on M.P.Bronshtein [8]) and non-stationary (!) *the long-range actions physics* (non-Newtonian / non-Coulombian): the macroscopic spacelike vacuum structures (discrete / crystal-like) is participate in formation of the annihilation mechanism *o-Ps* in different extent – in'the resonance conditions" [2,3] and in not resonant conditions [4,9]). The final state of the β^+-decay is described as the "defect" of the General Relativity (GR) space-time (the limited macroscopic "volume") as a result of the *topological quantum transition* (TQT). From the experiments position [2,3,4] and from the phenomenology [5] our consideration is limited by TQT such as $\triangle {\rm J}^\pi = 1^+$: ^{22}Na, ^{68}Ga, etc. The quantitative description of *o-Ps* anomalies is received (the "isotope anomaly" [3] and the "$\lambda_{\rm T}$-anomaly" [4]) and necessity of continuation of search of reliable criteria of the other macroscopic effects, received in conditions having the TQT quality, –

effects is proved, which are excluded by examination from the SM positions (in a broad sense – from the "$cG\hbar$- theory" positions) [10].

In a way of receiption of positrons $p \to n + e^+ + \nu$ (in a nucleus), which then at interaction with atoms/molecules of substance form the positronium, the nature of neutrino is attract special attention. Still in first half 1980th, to the fiftieth anniversary of a hypothesis of W.Pauli about neutrino, B.M.Pontekorvo did mark "...huge growth of the neutrino physics, which became a quantitative science, healthy and powerful, and nevertheless promising qualitative unexpectedness" [11].

So, the designated prospect of becoming of the "additional $G\hbar/c$-physics" is connected, first of all, to not trivial aspect of the β^+-decay, what for the first time was showed at studying the lifetime spectra of positrons annihilation (^{22}Na) in gaseous neon of the various isotope compositions [2,3,12].

It is interesting that works, in which the mathematical bases of the non-standard theory neutrino are submitted [13], have been published within opening supersymmetry.

This is the abstract the first of these works:

"Among the unitary irreducible representations of the Poincare group classified by Wigner, there occurs a class of mass-zero representations $O'_+(\rho)$ which has not hitherto been used for the description of known elementary particles. For historical reasons, these are called "continuous-spin" representations. They are labeled by values of the Poincare invariants $P^2 = 0$, $W^\alpha\ W_\alpha = -\rho^2$, with $\rho > 0$. *We propose to assign one or both neutrinos ν_e, ν_μ to such a representation. A corresponding neutrino can exist in a denumerable set of helicity states , with assuming all half-odd-integer values* $\lambda = \pm 1/2, \pm 3/2, ...$. We present a theory of weak interactions with such continuous-spin neutrinos. It differs from the conventional $V - A$ theory with two-component neutrinos in the form of the leptonic current. The predictions of the latter are approached as a limit when $\rho \to 0$. Explicit expressions for the matrix elements of the new leptonic current are derived. Lepton numbers are conserved if all the neutrinos and antineutrinos are distinct particles. It is, however, also possible in this theory, and consistent with present experimental evidence, to identify either $\nu_e \equiv \overline{\nu}_e$ or $\nu_\mu \equiv \overline{\nu}_\mu$. Lepton-number-nonconserving processes are then allowed, through suppressed if ρ is small".

In the more precise variant of this work ([13], 1971) the place of the summary italicized by us is changed and added. In this last variant of the work, unitary representations considered do not connected exclusively with neutrino. The prospective hypothesis of their identification in the nature is less specific and is expanded also on particles with integer helicity:

"*A corresponding particle can exist in a denumerable set of helicity states* $\lambda = 0, \pm 1, \pm 2, ...$ *or all half-odd integer values* $\lambda = \pm 1/2, \pm 3/2, ...$". This addition has basic meaning for the identification of the theory [13] with the orthopositronium anomalies [2-4], undertaken by us here.

For these works [13] *one and only* commentary on possible connection of these *lightlike* representations of the Poincare group with an indefinite-component non-local field [14] has followed. On the other hand, non-locality in the quantum field theory is described by *spacelike* irreducible unitary representations:

"As to hyperboloids $p^2 = C < 0$ to them too there correspond irreducible representations of the Poincare group, but not having physical sense: on such subspace the operator of a square of mass accepts negative value C, meanwhile as the mass of a particle on existing

representations should be non-negative" ([15], p.205).

"These irreducible unitary representations have been associated with "spacelike particles" – the so-called *tachyons* – which, if they exist, are interpreted as faster-than-light particles [16]" [17].

The author of concept VSM [6] at the moment of its publication adhered to such comprehension, referring to the monograph [18]: in the beginning of chapter VII, §1 is marked that "the idea of a space-time of constant curvature < K> of either sign is stimulating and worth exploring". In end of §1 is conclusion: "For K < 0, the timelike geodesics < ...> are closed curves < ...> . This depicts what can only be described as fantastic situation. We see a test particle repeating its history over and over again! This is at variance with our basic ideas of causality, and we conclude that a de Sitter universe with K negative involves ideas of altogether too revolutionary a character for physics as it exists today" (1960!).

More profound analysis is shown that "...there are closed timelike lines in this space; however it is not simple connected, and if one unwraps the circle S′ (to obtain its covering space R′) one obtains the universal covering space of anti-de Sitter space which does not contain any closed timelike lines" [19, p.131].

The interdisciplinary physical status of the *o-Ps* problem is obvious, as the phenomenology of "additional physics" is formulated at a level of the groups theory, the physical theory of dimensions and structures of superconstants of physics (G – a gravitational constant, c – speed of light, $\hbar$– Planck's constant) and of the fundamental constants:

- the fine structure constant
$$\alpha = \frac{e^2}{\hbar c} \ ;$$
- the dimensionless constant of the gravitational interaction
$$\alpha_{\rm g} = G\frac{m_{1.}m_2}{\hbar c} \ ;$$
- the ratio of proton and electron mass
$$\frac{m_p}{m_e}$$

and also fundamental (plus/minus) masses: Planck mass (1899)

$$\mathrm{M}_{Pl} = \pm \ (\hbar \cdot c)^{1/2} \cdot G^{-1/2}$$

and Stoney mass (1881)

$$\mathrm{m}_S = \pm \ e \cdot G^{-1/2} \ .$$

The structure of these dimensionless constants is those that it supposes physical interpretation both positive values of fundamental mass and their negative values [7,20], and also negative values of two out of three superconstants of physics – $\hbar$[20] and c [21].

It is possible to think, that similar development of physics was expected by L.D. Landau who did not presuppose epoch of the *quantum chromodynamics* (QCD). In last publication – "*About fundamental problems*" – Landau has assumed "...that the Hamilton method for strong interactions has become obsolete and should be buried, certainly, with all honors which it has deserved" [22]. Becoming and development QCD was, as though, strong counterargument. There is much speculation that in it a mistake outstanding physics. We see

in it depth of a prediction – in fact a splintered electric charge of quarks and confinement them are inconceivable in real life of the observer; it is much more natural to present magnetic monopole, which will serve a substantiation of the fundamental fact of quantization (unity) an electric charge of all free particles [10]. If the understanding of "*mechanisms*" of *consciousness* – one of the "great" problems of physics [23] – will demand expansion of fundamental bases, nevertheless it will take place not in terms QCD ("color", "confinement", "asymptotic freedom").

Let's repeat: at any development of physics the Hamilton method remain a basis of calculation of any "local" processes, and all polemic, which has arisen on this ground can mean that the physics has achieved a *point* (moment) *of a bifurcation,* when on base of the "$cG\hbar$-theory" and of the newest investigations and generalizations the new physics (the "additional $G\hbar/c$-physics") is "germinate". The Hamilton method is and remain always a basis for calculation of contributions of elementary processes ("local" – in the "$cG\hbar$-theory") and on it its role comes to an end, making way to an algorithm of a macroscopic "factor of strengthening" [2,5,10].

The presented reasons the concept of the C-field with a negative energy density [7] justify as compensating for field VSM [6], in view of what probably "...the simultaneous creation of quanta of fields of positive energy field and of negative energy C-fields" ([19], p.90).

In the quantum field theory the substantiation of such "creation" VSM "out of nothing" can be achieved by development of the *concept of a full relativity*: expansion of symmetry of the equations "...up to a full relativity, i.e. equivalence of all velocities (except the velocity of light)" predicts existence "...not electromagnetic long-range interactions of a bodies with not disappearing average of a spin density. In usual conditions to provide sublight character of relative velocities, additional symmetry should be broken spontaneously. Restoration of $<$ symmetry$>$ should be accompanied by doubling of the space-time dimension" [24].

The full relativity in other terms (*a method of an* A.L.Zelmanov's *chronometric invariants*) is submitted in the theory of *zero-space* (and *zero-particles in generalized space-time*), developed independently as expansion of the GR space-time [25].

Suggested in [13] non-standard concept of the nature neutrino till now has not received any identification in experiment. Publication of the CP-invariant version of the mirror universe [26], supervision of the *o-Ps* anomalies in the experiments published after that [3,4] and phenomenological model, in which the *o-Ps* anomaly have received a quantitative substantiation [2,5] – all this has created preconditions of such identification: standard representation of the electronic neutrino is realized during the electronic capture in atom (K-capture) and, probably, in the β^+-decay such as $\triangle \mathrm{J}^\pi \neq 1^+$, but in the β^+-decay of the nucleus such as $\triangle \mathrm{J}^\pi = 1^+$ the non-standard concept "neutrino" [13] are realized. In these transitions, alongside with neutrino it is realized "atom" VSM with Planck mass in the limited macroscopic "volume" of space-time

$$\mathrm{M}_{Pl} = (\hbar \cdot c)^{1/2} \cdot G^{-1/2}$$

and the C-field compensating it – the "mirror Universe" with negative mass [1,4]

$$\mathrm{M}_{Pl} = -\ (\hbar \cdot c)^{1/2} \cdot G^{-1/2}\ .$$

In Standard Model the concept of the mirror world (universe) has appeared as consequence of breaking of the P- and CP- invariance in the weak interactions. It is appropriate

to emphasize at last, that inverted commas in our version of the "mirror Universe" [2,5,10,12] emphasizes indirect cosmological aspect (mirror galaxies, stars, planets can not exist in the nature). But can be real an "additional cosmology" ("microstructure" of vacuum).

This complex "VSM + C-field" (the "atom of long-range action") present potentially in any "point" of space-time but realized in final state of the β^+-decay of the nucleus such as $\triangle \mathrm{J}^{\pi}= 1^+$, represents of the vacuum "microstructure".

All told with take into account the "mirror Universe" is realized in additional mode of the *o-Ps* annihilation [2-4] *o-Ps* $\setminus$ *o-Ps*$^{'}$(*p-Ps*$^{'}$) $\rightarrow$ $\gamma^{\circ} \setminus 2\gamma^{'}$, where γ° – the notoph: "*...a massless particle with zero helicity, additional on the properties to photon (helicity* ± 1*). In interactions notoph, as well as the photon, transfers spin* 1" [27]. This work, though in it was not obvious generalizations at a level of the Poincare group, it is possible to consider as the forerunner of the works [13].

Representation of the β^+-decay of the specified type now looks so $p \rightarrow n + e^+ +$ "ν" (in a nucleus + a "macrovolume" of space-time), where "ν " designates superposition of the standard neutrino and a spacelike complex "VSM+C-field" that can be characterized in terms of works [13] as "Continuous-Spin" Neutrino + " Massless Particles: the Continuous Spin Case".

In many outlines the concept of the "additional physics" in the limited "macrovolume" of space-time has a solid-state aspect; first of all, paradoxical realization of a *nuclear gamma resonance* testifies to it in a gaseous (!) neon of the natural isotope composition that stimulated supervision of the *o-Ps* "isotope anomaly" [2,3,5,10]: "particles" (positive mass m_p, m_e) and "holes" (negative mass – in the "mirror Universe" $-m_p$, $-m_e$) in an "units" of cells 3-dimensional space-like (crystal-like) structures (the "atom of long-range action") – the common number

$$\mathrm{N}^{(3)} = \frac{2^{9/2}}{3\pi^2 \cdot \alpha^9} = 1.302 \cdot 10^{19}, \tag{6}$$

with the "lattice" constant

$$\Delta \sim c \cdot \triangle t_{\mathrm{v}} = \frac{4}{\alpha^4}\left(\frac{\hbar}{m_e \cdot c}\right) \cong 5.5 \cdot 10^{-2}\mathrm{cm} \tag{7}$$

($\triangle t_{\mathrm{v}}$ – time of existence the *o-Ps* in the form of one virtual photon) and sum total mass $\mathrm{M}_{Pl} = \sqrt{\frac{\hbar c}{G}}$ plus $\mathrm{M}_{Pl} = -\sqrt{\frac{\hbar c}{G}}$ and "...a nucleus of atom of long-range action", containing $\overline{\mathrm{n}} = 5.2780 \cdot 10^4$ cells-"units" ($2\mathrm{r}_{\overline{\mathrm{n}}} \sim 2.6$ cm), which defines the contribution of an "additional physics" in the *o-Ps* "isotope anomaly" in neon (at the "conditions of a resonance", the factor $\sim$2) [2,3,5,10] and in the *o-Ps* "λ_{T}-anomaly" in a not resonant conditions (0.19$\pm$0.14)% [4,9].

It appears also, that the "atom of long-range action" (the "microstructure" of vacuum) can be presented as an space-time "exciton".

Really, the antipodal pair "electron (e)-electronic hole ($\overline{e}$)" in the final state of the β^+-decay together with the antipodal pair "proton (p)-proton hole ($\overline{p}$)" "annihilate" along a symmetric variant – "from the leptons up to leptons":

$$e\overline{e} \Leftrightarrow p\overline{p} \Rightarrow \{13\frac{\pi^+\pi^-}{\overline{\pi}^-\overline{\pi}^+}\ (\tau_{\pi^{\pm}} \sim 2.6 \cdot 10^{-8}\mathrm{s}) \rightarrow 13\frac{\mu^+\mu^-}{\overline{\mu}^-\overline{\mu}^+}\ (\tau_{\mu^{\pm}} \sim 2.2 \cdot 10^{-6}\mathrm{s}) \rightarrow 13\frac{e^+e^-}{\overline{e}^-\overline{e}^+}\} \Rightarrow e\overline{e} \tag{8}$$

(brackets {...} include the compensating process in the "the mirror Universe" – in the "denominators").

This representation of model of fundamental space-like structure with plus/minus Planck mass $\mathrm{M}_\mu = \pm M_{Pl}$ gives the self-coordinated size of the "atom of long-range action" $2c \cdot \tau_\mu = 1.3$ km $\sim 2R_\mu$ and allows to offer expansion of the Huygens principle: the unit of cellular structure of space on border of the "atom of long-range action", in which there is a "teleportation" initial $e\overline{e}$-"pairs", becomes the center of the subsequent act of the "teleportation" – so there is a casual wandering such centers, i.e. the long-range action in the volume of the "atom" of a defect of space-time is propagated as *diffusion waves*. Really, the received estimation of the size of the "atom" can be presented as its "step" of the diffusion propagation $L_0 = 2R_\mu$

$$L_0 = \sqrt{2D\tau_\mu} = \sqrt{2(L_0 \cdot c)\tau_\mu}, \tag{9}$$

where D – the diffusion coefficient. Both decisions of the equation (9) – $L_0 = 0$ and $L_0 = 2R_\mu$ mean that at the first stage during time τ_μ diffusion (wandering "on a place" owing to "self-promotion" [28] with characteristic time $1/\Omega \sim 10^{-44}$s) should have character of casual rotation in the volume of the "atom". Plus/minus Planck mass

$$\mathrm{M}_{Pl} = \pm(\hbar c)^{1/2} \cdot G^{-1/2} \equiv 2.177 \cdot 10^{-5}\mathrm{g}\ ,$$

it is submitted, according to (6), through the fine structure constant α and masses m_p and m_e [5]

$$\mathrm{M}_\mu = \mathrm{N}^{(3)} \cdot (m_p + m_e) = \frac{2^{9/2}}{3\pi^2\alpha^9} \cdot (m_p + m_e) \equiv 2.179 \cdot 10^{-5}\mathrm{g}\ .$$

It means, that each of $\sim 10^{19}$ cells of spacelike structure is displayed in each of $\sim 10^{19}$ "mirror" cells on the mechanism of a tachyon self-promotion [28,2,12]. At the second stage diffusion on distance L to the moment t ($t = 0$ in moment of the β^+-decay) takes place

$$L = 2\sqrt{\frac{t}{\tau_\mu}}R\ .$$

As it is already noticed above, such discrete structure in the limited "volume" of space-time (the "atom of long-range action") on background GR can be submitted as the "defect" of space-time, which is formed in a the final state of *topological quantum transition*. If the "atom of long-range action" at the moment of a birth in the final state of the β^+-decay or as a result of the subsequent diffusion appears in a gravitational field with critical value of the free falling acceleration γ_{cr} there is its "splitting" on the plus/minus Planck masses (the *generalized displacement current*), i.e. in one-stage (from "nothing"!) "elementary" macroscopic "domain" of a dark matter with the mass $2|\mathrm{M}_{Pl}|$ is born. The critical acceleration we shall estimate, using the Compton length of a wave of the proton and the "time of rest" (the time of one "step") of the "atom of long-range action" [5]

$$\gamma_{cr} = \frac{\hbar}{m_p \cdot c \cdot \tau_\mu^2} = \frac{\hbar c}{m_p \cdot R_\mu^2} \sim 0.01\ \mathrm{cm/s^2}. \tag{10}$$

Let's carry out the necessary estimations and, as far as possible, we compare them with the available cosmological data on the contribution of a dark matter. So, from (6) and (7) it is received an absolute value of the "baryon matters" density (VSM + C-field) in the final

state of the β^+-decay of a nucleus in the volume $V_\mu = \mathrm{N}^{(3)} \cdot \Delta^3$ and in the gravitational field of sufficient force

$$\rho_{|\pm \mathrm{M}_{Pl}|} = \frac{2\mathrm{M}_{Pl}}{V_\mu} \cong 2 \cdot 10^{-20} \mathrm{g} \cdot \mathrm{cm}^{-3} \ . \tag{11}$$

The density (11) should be compared to the value of the density of a dark matter accepted for today in the Universe. From (2) and (11) it is received

$$\rho_{\text{“D”}} = f_{\mathrm{U}} \cdot \rho_{|\pm \mathrm{M}_{Pl}|} \sim \Omega_{\mathrm{D}} \cdot \rho_{\mathrm{c}} \ ,$$

where f_{U}– the “universal” factor, which is taking into account the all sources and the physical (an “additional physics”) mechanisms of participation of the spacelike structure accompanying each act of the β^+-decay in the final state in view of a possible mechanisms of its “dissipation” or disappearance. As shown above, the spacelike structure in the final state of the β^+-decay can diffusion from areas of the Universe, where gravitation is enough for display $\pm \mathrm{M}_{Pl} \Rightarrow 2\,|\mathrm{M}_{Pl}|$, into the “free Cosmos”, where the mass of the spacelike structure is defined by Heisenberg uncertainty relations

$$m_\mu \cong \frac{\hbar}{2R_\mu \cdot c} \sim 10^{-10} \mathrm{eV},$$

and again in those areas of Cosmos, where by criterion (10) its mass $2\,|\mathrm{M}_{Pl}|$ will be shown; the index in $\rho_{\text{”D”}}$ reflects hypothetical character of an estimation. We receive

$$f_{\mathrm{U}} \sim \frac{\Omega_{\mathrm{D}} \cdot \rho_{\mathrm{c}}}{\rho_{|\pm \mathrm{M}_{Pl}|}} \sim 10^{-10} \ . \tag{12}$$

It is visible, as far as it is complex and, probably, even unattainable the task of a full substantiation of an estimation f_{U}, but it does not change the basic attitude to the considered mechanism of a dark matter formation. The reality of this program can be confirmed or denied as a result of realization *experimentum crucis* for the decision of the *orthopositronium problem* [5] and forthcoming *cosmological (astrophysical) estimations of the “universal” factor* f_{U}.

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